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Original Article

The effect of an early oral stimulation program on oral feeding of preterm infants

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ABSTRACT

Purpose: To evaluate the effect of an oral stimulation program on preterm infants.
Methods: Preterm infants ($n = 72$) were randomly assigned to experimental and control groups. Controls ($n = 36$) received routine care while the experimental group ($n = 36$) received oral stimulation in addition to routine care. Postmenstrual age, total intake volume, body weight, the transition time from initiation of oral feeding to full oral feeding and feeding efficiency were calculated.
Results: Postmenstrual age and full oral feeding weight were significantly lower in the experimental group ($p < 0.05$). The time from initiation of oral feeding to full oral feeding was significantly shorter in the experimental group ($p < 0.05$) while feeding efficiency was higher in the experimental group ($p < 0.05$) compared to controls. No significant differences existed in hospital stay length or weight gain rate.
Conclusions: An early oral stimulation program is beneficial in preterm infants.

1. Introduction

Due to their underdeveloped central nervous system and oral musculature, preterm infants frequently experience oral feeding difficulties, with coordination lacking for the suck-swallow-breath mechanism [1,2]. Preterm infants rely on administered feedings and parenteral nutrition to ensure proper nutritional requirements are met. Adverse effects, however, are increased due to the lack of stimuli from the gastrointestinal tract [3–5]. Safe and successful suckle feeding, via breast or by bottle, is one requirement for hospital discharge and an ultimate goal for preterm infant feeding [6]. Thus, facilitating oral feeding skills and helping preterm infants transit to full oral feeding are a key focus for the medical staff of neonatal intensive care units (NICUs).

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Table 1 – Baseline characteristics of preterm infants in the experimental and control groups ($\bar{x}$ ± SD).

Characteristic	Experimental group ($n = 32$)	Control group ($n = 31$)	Statistic value	p Value
GA (weeks)	30.87 ± 1.47	30.92 ± 1.48	−0.146[a]	0.885
Weight (g)	1597.38 ± 264.263	1652.50 ± 327.468	−0.983[a]	0.329
Sex				
Male	16	16	0.016[b]	0.549
Female	16	15		
1 min Apgar score	7.78 ± 2.324	7.38 ± 2.420	0.685[a]	0.496
5 min Apgar score	8.55 ± 1.929	8.45 ± 1.997	0.194[a]	0.847

GA: gestational age.
[a] t Value.
[b] χ^2 Value.

Early oral motor interventions (OMIs) are beneficial for oral feeding in preterm infants. OMI is defined as sensory stimulation of the lips, jaw, tongue, soft palate, pharynx, larynx and respiratory muscles, which are thought to influence the physiological underpinnings of the oropharyngeal mechanism in order to improve its functions. Previous research abroad has shown that OMI can shorten the transition time from gavage feeding to full oral feeding and improve oral feeding efficiency [7]. There is no research domestically, however, to evaluate the effects of early OMI. The purpose of this study was to evaluate the effect of an early oral stimulation program on oral feeding in preterm infants to better inform clinical treatment of preterm infants.

2. Methods

2.1. Participants

This study was a randomized controlled trial and was conducted at a level three NICU in the Children's Hospital of Fudan University (Shanghai, People's Republic of China) from November 2011 to May 2012. Infants were enrolled if they were: (1) born between 29 and 34 weeks gestational age (GA) as determined by obstetric ultrasonogram and clinical examination; (2) received all feedings through a tube; (3) stable vital signs; (4) without congenital anomalies or severe complications. The following exclusion criteria were applied: (1) infants with medical complications, such as grade III or IV intraventricular hemorrhage or periventricular leukomalacia; (2) congenital diseases such as chromosomal or genetic abnormalities, neurological abnormalities, complex congenital heart disease, congenital gastrointestinal malformations or bronchopulmonary dysplasia; (3) severe asphyxia; (4) severe infections; (5) severely undersized for GA; (6) other serious complications such as necrotizing enterocolitis (NEC). Informed parental consent was obtained before participants' entry into the study.

Seventy-two preterm infants were randomly assigned into the experimental group or the control group using computer-generated random number assignment. Briefly, the sample size was numbered from 1 to 72 using the random number generator feature in Microsoft Excel. Infants that received numbers 1–36 were assigned to the experimental group while infants receiving numbers 37–72 were assigned to the control group. The order of the allocation sequence was saved and sealed in an envelope; the researchers opened the envelope and recorded groups when infants met the inclusion criteria and after parental informed consent was obtained.

Of the 72 participants enrolled, four withdrew from treatment, one was transferred to another hospital, two were found to have a congenital heart defects and thus were transferred to other department and two developed NEC. Thus, 63 infants completed the study, with 32 patients in the experimental group and 31 in the control group. All participants had statistically similar baseline characteristics (Table 1). No differences were observed with respect to GA, birth weight, sex, 1 min Apgar score and 5 min Apgar score ($p > 0.05$) (Table 1).

2.2. Interventions

The experimental group received the exact oral stimulation program developed by Fucile [8] et al., which consisted of 12 min of oral stimulation and 3 min of non-nutritive sucking (explicit details of which can be found in Table 1 of Fucile [8] et al.).

The interventions started 48 h after discontinuation of nasal continuous positive airway pressure, and were continued until the newborn began an exclusively oral diet. The oral stimulation program was administered once a day 15–30 min before the beginning of a scheduled feeding. Interventions were not administered in the case of medical instability, decreased oxygen saturation, proven apnea or bradycardia.

The control group received routine feeding care administered by the NICU. The doctor prescribed an appropriate milk volume according to gastric function, GA, etc. The infant was fed once every two hours and a supporting position was used during the feeding process in order to avoid the limitations from the neck and shoulder musculature. If necessary, the nurses pulled out the pacifier 3 to 5 times during the feeding sessions to allow the preterm infants to rest.

2.3. Outcome measures

The oral feeding progression was measured as the difference in oral feeding progression time between the experimental and control groups. The initiation of oral feeding was defined as the first oral feeding (≥5 mL/each time). Independent oral feeding was defined as the point at which the nasogastric tube was removed for 48 h and all milk volume per day was taken

Table 2 – Oral feeding progression between the experimental and control groups ($x \pm SD$).

Group	PMA at introduction of oral feeding (weeks)	PMA at independent oral feeding (weeks)	Transition time (days)	Parenteral nutrition duration (days)
Experimental group ($n = 32$)	33.40 ± 0.86	34.70 ± 1.03	9.56 ± 4.43	25.38 ± 13.675
Control group ($n = 31$)	33.81 ± 1.43	35.66 ± 1.49	13.19 ± 6.18	25.48 ± 12.09
Statistical value	−0.85[a]	−2.99[b]	−2.69[b]	−0.03[b]
p Value	0.393	0.004	0.009	0.973

PMA: postmenstrual age.
[a] Mann–Whitney U value.
[b] t Value.

from a bottle at 120 mL/kg d^{-1}. The transition time was defined as the number of days between the introduction of oral feeding to obtaining autonomous oral feeding [9]. Infant postmenstrual age (PMA) at the two feeding milestones was recorded.

Oral feeding performance/efficiency was defined as the volume of milk consumed relative to the duration of the oral feeding session [mL/min]. The volume transfer was defined as the volume consumed as a percentage of the prescribed volume [%]. The nurse on duty, who was blind to the group assignments, recorded the duration and volume in every observed oral feeding session.

Weight gain was measured by recording the weight every day and calculating the weight gain rate by the following formula: weight gain rate [g/(kg × d)] = [1000 × ln (weight when discharged/birth weight)]/(days of life when discharged − days needed to recover to birth weight) [10].

The length of hospital stay was calculated from the recorded date of admission and date of discharge from the hospital.

We also recorded other factors that may influence oral feeding such as the episodes of apnea, bradycardia and/or oxygen desaturation during the oral feeding session and behavioral state at the start of the feeding session using the Anderson Behavioral State Scale [11].

2.4. *Statistical analyses*

All statistical analyses were conducted using SPSS16.0 (IBM, Chicago, IL, USA) statistical software. Data are presented as mean ± standard deviation ($x \pm SD$) for continuous variables with normal distribution and n (%) for categorical variables. A t test and non-parametric test were used to compare the differences between the two groups.

3. Results

There was no difference in the PMA between the two groups at the time when the infants initiated oral feeding, while the PMA in the experimental group was significantly lower than that in the control group at independent oral feeding ($p < 0.05$). The transition time in the experimental group was significantly shorter than that in the control group ($p < 0.05$). There was no difference in the parenteral nutrition duration between the two groups ($p > 0.05$) (Table 2).

There were no differences in the episodes of apnea, bradycardia and/or oxygen desaturation during the two oral feeding sessions or behavioral state at the start of the feeding session between the two groups. The experimental group had a significantly higher feeding efficiency than the control group at the initiation of oral feeding ($p < 0.05$). No differences were observed in the feeding efficiency between the two groups upon reaching the full oral feeding ($p > 0.05$) (Table 3).

There was no difference in weight at the initiation of oral feeding, while the experimental group had significantly lower weight than the control group upon reaching independent oral feeding and discharge from the hospital ($p < 0.05$). There were no differences in the days recovered to birth weight and weight gain rate during the hospital stay between the two groups (Table 4).

The average length of hospital stay in the experimental group was 39.97 ± 14.81 d, while the control group was 41.25 ± 16.15 d. There was no difference in the length of hospital stay between the two groups ($p = 0.724$).

A total of 10 incidences in the experimental groups were recorded during the intervention process due to a delay or stopping halfway. Eight of the incidences were caused by a delay because the infants were disturbed by medical or nursing intervention (e.g. infusion and catheterization 30 min

Table 3 – Oral feeding performance between the experimental and control groups ($x \pm SD$).

Group	Efficiency at introduction of oral feeding (mL/min)	Volume transfer at introduction of oral feeding (%)	Efficiency at independent oral feeding (mL/min)
Experimental group ($n = 32$)	5.254 ± 3.36	0.81 ± 0.24	10.41 ± 4.42
Control group ($n = 31$)	3.522 ± 2.70	0.71 ± 0.28	8.15 ± 4.66
Statistical value	2.25	1.58	1.97
p Value	0.028	0.118	0.053

Table 4 – Weight gain between the two groups ($\bar{x} \pm SD$).

Group	Weight at introduction of oral feeding (g)	Weight at independent oral feeding (g)	Discharge weight (g)	Days recovered to birth weight (days)	Weight gain rate
Experimental group ($n = 32$)	1663.28 ± 173.40	1836.09 ± 193.04	2086.56 ± 115.24	13.61 ± 5.04	11.39 ± 3.86
Control group ($n = 31$)	1752.58 ± 254.40	2002.90 ± 203.41	2178.39 ± 210.02	13.87 ± 4.29	11.05 ± 3.73
Statistical value	−1.63[a]	−3.34[a]	−2.06[b]	−0.21[a]	−0.35[a]
p Value	0.108	0.001	0.040	0.833	0.728

[a] t Value.
[b] Mann–Whitney U value.

prior to the program) and two sessions were halted after the infants suffered an episode of bradycardia, which resolved spontaneously.

4. Discussion

Preterm babies frequently experience many difficulties after birth and nutritional problems are one of the major challenges. Preterm babies born at less than 34 weeks of GA have an uncoordinated suck-swallow-breath pattern and cannot be fed by mouth successfully or safely. Thus, it is necessary to evaluate whether an oral stimulation program is beneficial in accelerating the rate to oral feeding for preterm infants. The program in our study consisted of 12 min oral stimulation and 3 min non-nutritive sucking and stroking of the oral structures. The first component of the oral stimulation program may cause a strengthening of the oral musculature, which is necessary for adequate sucking. Non-nutritive sucking, the second component of the program, may promote more efficient engagement of neuromuscular structures and with greater endurance. The program, when implemented as a whole, may enhance the maturation of central and/or peripheral neural structures, leading to improved sucking skills and coordination of the suck-swallow-breathe pattern [8].

4.1. *An oral stimulation program contributes to progression of independent oral feeding*

Universal clinical guidelines for oral feeding of preterm infants around the world currently do not exist [9]. In our study, there was no difference in the PMA when the two groups began oral feeding, which is consistent with the research proposed by Fucile et al. [8], Rocha et al. [12] and Bragelien et al [13]. The average PMA at the initiation of oral feeding in our study was 33.60 weeks, which is similar to the domestic research performed by Wentao Peng [9]. The average PMA from research performed abroad, however, is 34.31 weeks [14], which is slightly different than our results. This difference may be attributed to the lack of an oral feeding progression management program; most NICUs simply use GA or weight to determine when to begin oral feeding and ignore individual differences [15]. The PMA in the experimental group was significantly lower than that in the control group upon reaching independent oral feeding in our research, which is in contrast to the data presented by Rocha et al [12]. The days of life in the experimental group were lower than that in the control group from Rocha et al., which implies a positive effect by oral stimulation on the oral feeding.

Five to seven stages of feeding from parenteral nutrition to full oral feeding are usually required; the transition from gavage feeding to independent oral feeding represents the most important stage [9,11]. Several researchers have reported the benefits of oral stimulation [8,12,16] and our results confirm that implementation of an oral stimulation program can shorten the time from gavage feeding to full oral feeding. In our research, we used introduction of oral feeding and independent oral feeding as the two oral feeding milestones, similar to the approach used by Rocha et al [12]. Other researchers have used the frequency of successful oral feedings per day (e.g. the number of days it takes to reach 1–2, 3–4 and 7–8 successful oral feedings per day) as the observation time point due to different oral feeding management programs [8,16,17]. One study [13] reported that oral stimulation had no benefit on the time to full oral feeding, but this discrepancy may be explained by differences in oral stimulation programs.

4.2. *An oral stimulation program contributes to oral feeding performance*

Feeding efficiency and volume transfer, monitored across an entire feeding session, are used as indices of oral motor function and endurance. In the research performed by Fucile [8,18] et al., the experimental group had a higher oral feeding efficiency when compared to the control group upon reaching 1–2, 3–4 and 6–8 successful oral feedings per day. Our results similarly indicate that oral stimulation had benefits on the feeding efficiency at the introduction of oral feeding. Although there was no difference between the two groups on the timing to reach independent oral feeding, this may be attributed to the time required for preterm babies to gather sucking experience. Feeding proficiency, which is measured during the first 5 min of a feeding, has also been recorded by some studies as an index of the infant's actual feeding ability when fatigue is minimal [19]. Research from Fucile et al. shows that oral stimulation improved the proficiency at the beginning of oral feeding. By the time both the experimental and control groups reached 6–8 oral feedings a day, the control infants attained the same level of nutritive sucking as those in the experimental group, albeit at a much slower pace and only during the first 5 min of feeding. The slower pace could be attributed to infant immaturity and/or decreased endurance [20]. The study by Fucile et al. did not address transfer volume as a feeding milestone during the first 5 min and thus it is not

possible to analyze proficiency, which could be a subject for future study.

There was no difference between the two groups in the volume transfer at the introduction of oral feeding, but a larger percentage of the experimental group reached 100% oral feeding, which is consistent with Fucile's research [8]. As time progressed, volume transfer increased and ultimately reached 100%, confirming the hypothesis proposed by Lau et al., that oral feeding is a learned behavior that can be improved through the accumulation of experience [19].

4.3. *The effect of oral stimulation on weight gain*

For preterm infants, oral feeding takes more energy and excessive oral feeding may lead to fatigue, ultimately impacting weight gain [21]. Successful oral feeding is defined as the point at which a preterm infant can finish the prescribed milk volume and gain the expected amount of weight. There was no difference in weight when oral feeding was introduced to the experimental and control groups, which is in contrast to the study from Rocha et al [12]. This unexpected difference may be explained by the different approaches to oral feeding progression management [12]. The experimental group had a lower average weight upon reaching independent oral feeding when compared to the control group, which is consistent with a lower PMA. The experimental group also had a lower weight than the control group when they were discharged from the hospital because administration of oral simulation shortened the amount of time gavage was required, thus promoting earlier discharge. Previous studies have used different weight gain indices. In the study performed by Rocha et al., [12] the average weight gain per week was recorded while our study measured the weight gain rate during the entire hospital stay. However, oral stimulation had no effect on weight gain; when measured according to the outcomes, other factors may influence the weight.

4.4. *The effect of oral stimulation on the length of hospital stay*

We observed no difference in the length of hospital stay in our study, contrary to previous research, which reported that the length of hospital stay was shortened by as many as 110.4 days [12]. Generally, preterm infants are discharged from the hospital approximately 7 days after they attain full oral feeding. Adverse medical events such as infection, unstable respiration, lack of readiness on the part of the caregiver(s) or a weight less than 2 kg can prolong the length of hospital stay. Because there are very specific criteria to discharge infants from the hospital, this likely is an added confounding variable in the current study.

5. Conclusion

Implementation of the oral simulation program in this study shortened the transition time from introduction of oral feeding to full oral feeding and improved the oral feeding performance. Because the pre-feeding oral stimulation program is safe, simple and beneficial to preterm infants, we propose that such an intervention should be implemented in the NICU.

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